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# ADOLESCENT GIRLS SKIRTS

## PART II. LABORATORY EVALUATION OF SKIRT FABRICS



CENTRAL REGIONAL RESEARCH PUBLICATION NO. 170


Agricultural Experiment Stations of Alaska, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and the U. S. Department of Agriculture, cooperating.

CULTURAL EXPERIMENT STATION • UNIVERSITY OF MINNESOTA

# Adolescent Girls Skirts

## Part II. Laboratory Evaluation of Skirt Fabrics

The North Central Regional Committee on Textiles and Clothing was concerned with the selection and use of girls winter skirts.

Part I discusses the attitudes, opinions, and preferences of mothers and daughters concerning fibers and fabrics used in girls winter school skirts.[1] The data indicated that wool and wool-like blends were preferred fabrics. Among qualities most often mentioned was the ability of a fabric to maintain its shape during wear and its original appearance after washing or drycleaning.

Based on these findings, a laboratory evaluation of wool and wool-like fabrics was conducted to determine laundering and drycleaning effects on the physical characteristics of such fabrics. Agricultural Experiment Stations which actively participated in part II of the investigation were: Illinois, Indiana, Kansas, Minnesota, Missouri, South Dakota, and Wisconsin.


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[1] *Adolescent Girls Skirts. Part I. Mothers' and Daughters' Opinions of School Skirts.* Univ. of Minn. Agr. Exp. Sta. Bull. 478. NCR 169. 1965.

# TESTING PROCEDURES

Madison, Wisconsin, and Chicago, Illinois, were chosen as sampling areas to determine availability of wool or wool-like fabrics suitable for girls skirts. From these findings an experimental design was planned on the basis of price and fiber content. Two price levels were available in five fiber groups; only one level was available in two additional groups (see table 1, page 4).

Twenty yards of each of the 12 fabrics were divided into four portions. These portions were then coded and distributed to the four agricultural experiment stations assigned the laundering and drycleaning treatments. Two of these stations also received extra lengths for the sampling of fabric without treatment. The lengths used for each treatment were divided into four parts. Fabrics were sampled and analyzed after 0, 1, 3, 6, and 10 treatments.

These four stations were responsible for collecting data on dimensional change and recording visual changes in fabrics after treatment. They sampled treated fabrics and distributed samples to stations cooperating in the laboratory evaluation. Plastic templates were used by the four stations to mark and cut samples.

## Cleaning Methods

### Drycleaning

Two stations, referred to here as M and W, conducted drycleaning trials. Fabrics were sent to commercial establishments and cleaned with regular loads of similar weight garments. The charged system, using a detergent with perchloroethylene solvent, was used for the cleaning cycle. Fabrics were rinsed in the usual manner with a clear solvent, dried in a tumbler, and pressed in open widths with the same time and pressure as normally used for such items.

When the fabrics were returned to the two laboratories, dimensional stability measurements were made and yardage removed at each treatment. All fabrics were rumpled before being returned to cleaners for retreatment.

### Laundering

Two stations, referred to here as A and T, were assigned the laundry trials. All fabrics used were gray in color but varied in shade; like value fabrics were laundered together.

Procedures at the two stations were as similar as possible. A 7-pound load was used. Filler fabrics of rayon-acetate suiting, lighter in color than the test fabrics, were used when necessary to complete a 7-pound load. Washings were done in softened water using a built synthetic detergent in the amount of 0.2 percent by weight of water.

**Table 1. Information on fabrics as purchased**

| Fabric code* | Approximate cost per yard | Where purchased | Additional label information |
|---|---|---|---|
| W-1 ..... | $4.65 | Mail-order house | Double sponge-decated; 100 percent wool |
| W-2 ..... | 3.00 | Department store | 100 percent wool |
| WN-1 ..... | 3.00 | Mail-order house | 85 percent wool, 15 percent nylon |
| WN-2 ..... | 4.50 | Department store | Dylanize, washable; 85 percent wool, 15 percent nylon |
| WA-1 ..... | 2.85 | Mail-order house | 60 percent Orlon acrylic; 40 percent wool |
| WA-2 ..... | 3.00 | Department store | 65 percent Orlon acrylic, 35 percent wool |
| WP-1 ..... | 4.00 | Department store | 75 percent wool, 25 percent Dacron polyester |
| R-1 ..... | 2.00 | Department store | Washable, wrinkle-resistant finish; 100 percent Coloray spun rayon |
| RT-1 ..... | 1.00 | Mail-order house | 70 percent rayon, 30 percent acetate |
| RT-2 ..... | 2.00 | Department store | Crease-resistant; 70 percent rayon; 30 percent acetate |
| RA-1 ..... | 2.50 | Department store | 70 percent Acrilan acrylic, 30 percent rayon |
| RA-2 ..... | 1.85 | Mail-order house | 50 percent Orlon acrylic, 50 percent spun viscose rayon |

* In fabric code, the letters refer to fiber content: W, wool; N, nylon; R, rayon; T, acetate; A, acrylic; and P, polyester.

Fabrics were washed about 2 minutes in 100-110° F. water temperatures. The cycle recommended for wool by the machine manufacturer was used. At station A, an agitator machine was used which automatically had a 68° F. rinse water with the 110° F. wash temperature. Agitation time was 1 minute and 50 seconds; the action was slow, as was the spin action for water removal.

A tumbler machine was used at station T. The machine, set for the regular load at warm on the wash-and-wear setting, gave a wash temperature of 106° F.±4° and a rinse temperature of 80°F.±4°. Agitation time was 2 minutes plus the regular rinsing cycle.

Drying was done in electric dryers using the cycle recommended by the manufacturer. At station A, fabrics were tumbled in hot air for about 5 minutes and then in cool air for 10 minutes. A "dewrinkle" or wash-and-wear setting was used. At station T, fabrics were tumbled about 15 minutes. The temperature control was set at low and wash-and-wear. Drying time varied slightly due to fiber content and fabric weight.

Fabrics were removed while damp and stored in plastic bags until pressed. Fabrics were placed right side up on a silicone-finished ironing board cover and covered with a press cloth. Pressing was done in the warp direction using little or no pressure. Swatches, except the length on which the shrinkage square was marked, were then hung on a clothes-horse. The shrinkage square length was dried flat.

## Physical Analyses

Fabric and yarn properties were determined using: (1) American Association of Textile Chemists and Colorists methods, (2) American Society for Testing and Materials (ASTM) methods, and (3) Federal Specification Textile Test methods. All samples were brought to equilibrium under standard conditions of 65 percent ± 2 percent relative humidity and 70°F.±2° temperature.

Unused fabrics and those withdrawn after 1, 3, 6, and 10 launderings or drycleanings were analyzed for visual changes, fiber content, dye, finish, and yarn and fabric construction. The following physical properties and the instruments used to measure each were:

| Physical Properties | Type of Instruments |
|---|---|
| Tear resistance | Falling-pendulum (Elmendorf) apparatus |
| Pilling | Appearance retention tester |
| Stiffness | Stiffness tester (cantilever bending method) |
| Wrinkle recovery | Vertical strip apparatus |

In accordance with the statistical design, no more than two stations worked on a particular aspect of fabric performance.

The **dimensional change** of fabrics was measured on 18-inch squares marked on swatches to be laundered and/or drycleaned 10 times.

## Chemical Analyses

In general, ASTM D629-59T methods were used for determining moisture and fiber composition of study fabrics. Specific methods used for quantitative separations were:

| | |
|---|---|
| Wool-nylon blends | Method 3, section 14—28 percent hydrochloric acid |
| Rayon-acetate blends | Method 1, section 12—80 percent acetone |
| Rayon-acrylic blends | Method 4, section 15—70 percent sulfuric acid used instead of 59.5 percent to insure complete separation |

| | |
|---|---|
| Wool-acrylic and wool-polyester blends | Method 6, section 17—sodium hypochloride |

The procedure for removal and identification of nonfibrous materials was slightly modified. The enzyme treatment was omitted and toluene was substituted for dioxane for fabrics containing acetate.

## Stress-Strain Properties

Six warp and six filling specimens of each fabric were subjected to a cyclical tensile stress on a constant rate of load tester equipped with band clamps. Tests were for two periods of 4 hours each with 1 hour of recovery time between periods. The specimens included two untreated samples drycleaned 10 times at station W, one sample laundered 10 times at station T, and one sample laundered 10 times at station A. The 26- by 3-inch samples were sewn together on benchmarks 24 inches apart to form a 12-inch loop.

All samples were conditioned before being subjected to a testing load equal to one-fourth of their original breaking load. Stress-strain diagrams of both the cycle's load and unload portions were recorded for the 1st, 20th, and last cycles of each 4-hour period. Areas under the load and unload curves for the 1st and 20th cycles of the first period and the last cycle of the second period were measured using a planimeter. The following values were calculated:

$$\text{Percent work recovery} = \frac{\text{Area under unload curve}}{\text{Area under load curve}} \times 100 \text{ for each of the three cycles.}$$

$$\text{Percent work absorption retained} = \frac{\text{Area under last load curve}}{\text{Area under first load curve}} \times 100.$$

In addition, the unrecovered elongation or set was measured for the first and last cycles.

After stress, samples were allowed to recover for 24 hours or more while lying flat in a conditioned atmosphere. After reconditioning, samples were tested for thickness at pressures of 0.1 and 1.0 pounds per square inch. Differences in thicknesses at these two pressures were calculated and reported as the fabric compression.

Other fabric tests performed concerned thread count, weight, and wrinkle recovery. Fabric yarns were analyzed for tex, crimp, strength, and elongation.

## Statistical Procedures

Data were treated statistically by the analysis of variance. The significance of each source of variance was determined by the use of the "F" test. Significant differences were determined at the 0.05 level and at the 0.01 level.

# STUDY RESULTS

The discussion of results obtained in the study of fabrics suitable for girls winter school skirts is divided into five parts:

1. Physical characteristics of fabrics as purchased (see table 2, page 8).
2. Chemical analysis of fabrics as purchased.
3. Effect of drycleaning on certain physical properties.
4. Effect of laundering on certain physical properties.
5. Stress-strain properties of fabrics.

## Physical Characteristics of Fabrics as Purchased

**Weight**—Heaviest new fabrics were the acetate-rayon blends and the 100-percent wools. Lightest weight fabrics were the wool-acrylic blends followed by the wool-polyester and rayon-acrylic blends.

**Thickness**—Thickest new fabrics were the 100-percent wools and the wool blended with 15 percent nylon. Thinnest fabrics were composed of rayon and acrylic fibers.

**Tear Resistance**—In general, fabrics containing rayon had higher tear resistance than those containing wool. The rayon-acetate twill with its crease-resistant finish was less resistant to tearing than the rayon-acetate blend without such a finish.

**Stiffness**—Fabric stiffness was greater in the warp than in the filling. Fabrics containing rayon generally were stiffer than wool fabrics.

**Wrinkle Recovery**—The rayon and rayon-acetate fabrics scored lowest in wrinkle recovery. The other fabrics were all comparable.

**Pilling**—This characteristic was measured by the appearance retention tester. Fabrics containing wool exhibited the greatest tendency toward pilling; the rayon-acetate blends showed the greatest resistance to pilling.

## Chemical Analysis of Fabrics as Purchased

**Qualitative and Quantitative Analyses**—Analyses for both qualitative and quantitative fiber and finish were made at stations M and W. However, the percent moisture was determined only at station W. Both all-wool fabrics had considerable moisture, although one had more finish than the other (see table 3, page 9).

**Nonfibrous Materials (finish)**—Table 3 includes values for the total finish determinations at the two stations. In general, differences were 1

**Table 2. Physical characteristics of fabrics as purchased**

| Fabric code | Weave | Count | | Weight | Thickness | Tear resistance | | Drape stiffness | | Wrinkle recovery | | Pilling |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Warp | Filling | | | Warp | Filling | Warp | Filling | Warp | Filling | |
| | | yarns per inch | | ounces per square yard | inches | grams | | centimeters | | degrees | | rating |
| W-1 | Twill | 36 | 30 | 7.0 | 0.040 | 1,581 | 1,294 | 1.84 | 1.68 | 151 | 149 | 4.0 |
| W-2 | Plain | 30 | 22 | 6.8 | 0.028 | 2,269 | 1,531 | 1.86 | 1.64 | 154 | 156 | 4.0 |
| WN-1 | Twill | 33 | 26 | 6.2 | 0.032 | 1,812 | 1,431 | 1.76 | 1.55 | 149 | 149 | 4.0 |
| WN-2 | Plain | 31 | 28 | 6.8 | 0.034 | 2,462 | 2,325 | 1.88 | 1.70 | 152 | 153 | 4.0 |
| WA-1 | Plain | 36 | 32 | 4.0 | 0.020 | 2,800 | 2,244 | 1.54 | 1.36 | 162 | 159 | 4.0 |
| WA-2 | Plain | 38 | 27 | 4.7 | 0.023 | 1,794 | 1,312 | 2.21 | 1.68 | 150 | 147 | 3.9 |
| WP-1 | Plain | 28 | 25 | 4.6 | 0.021 | 1,175 | 938 | 1.54 | 1.48 | 153 | 152 | 3.6 |
| R-1 | Figure | 69 | 111 | 6.5 | 0.020 | 4,219 | * | 1.94 | 1.87 | 137 | 137 | 2.9 |
| RT-1 | Twill | 78 | 54 | 7.0 | 0.020 | 3,112 | 2,419 | 3.02 | 1.91 | 130 | 128 | 1.0 |
| RT-2 | Twill | 80 | 68 | 8.2 | 0.020 | 2,960 | 2,250 | 2.18 | 1.79 | 134 | 132 | 1.0 |
| RA-1 | Twill | 82 | 61 | 5.7 | 0.017 | 1,588 | 2,038 | 1.82 | 1.34 | 158 | 155 | 2.9 |
| RA-2 | Plain | 48 | 38 | 4.8 | 0.017 | 3,412 | 2,638 | 2.72 | 1.77 | 149 | 149 | 3.0 |

* Due to unbalanced structure, no reading was obtained.

**Table 3. Quantitative fiber and finish analysis of as-purchased fabrics**

| Fabric code | Fiber content information given purchaser | Percent moisture content | Percent total finish | | Percent fiber content | | | |
|---|---|---|---|---|---|---|---|---|
| | | Station W test | Station M test | Station W test | | Station M test | Station W test | Overall mean |
| W-1 | 100% wool | 7.36 | 3.16 | 3.65 | Not determined experimentally | | | |
| W-2 | 100% wool | 6.24 | 6.92 | 6.02 | Not determined experimentally | | | |
| WN-1 | 85% wool, 15% nylon | 5.68 | 5.99 | 4.98 | Wool: | 77.13 | 77.78 | 77.45 |
| | | | | | Nylon: | 22.87 | 22.22 | 77.45 |
| WN-2 | 85% wool, 15% nylon | 6.26 | 6.05 | 4.83 | Wool: | 75.12 | 74.89 | 75.01 |
| | | | | | Nylon: | 24.88 | 25.11 | 24.99 |
| WA-1 | 60% Orlon, 40% wool | 4.37 | 1.93 | 1.52 | Acrylic: | 61.89 | 60.81 | 61.35 |
| | | | | | Wool: | 38.11 | 39.19 | 38.65 |
| WA-2 | 65% Orlon, 35% wool | 3.71 | 3.18 | 3.71 | Acrylic: | 66.79 | 65.38 | 66.09 |
| | | | | | Wool: | 33.21 | 34.62 | 33.91 |
| WP-1 | 75% wool, 25% Dacron | 4.95 | 2.85 | 3.01 | Wool: | 65.70 | 65.56 | 65.63 |
| | | | | | Polyester: | 34.30 | 34.44 | 34.37 |
| R-1 | 100% spun rayon | 6.55 | 15.46 | 9.72 | Not determined experimentally | | | |
| RT-1 | 70% rayon, 30% acetate | 6.02 | 14.41 | 6.46 | Rayon: | 66.29 | 64.33 | 65.31 |
| | | | | | Acetate: | 33.71 | 35.67 | 34.69 |
| RT-2 | 70% rayon, 30% acetate | 6.48 | 15.36 | 13.10 | Rayon: | 69.48 | 68.79 | 69.14 |
| | | | | | Acetate: | 30.52 | 31.21 | 30.86 |
| RA-1 | 70% Acrilan, 30% rayon | 3.43 | 10.00 | 10.11 | Acrylic: | 68.96 | 69.50 | 69.23 |
| | | | | | Rayon: | 31.04 | 30.50 | 30.77 |
| RA-2 | 65% Orlon, 35% rayon | 4.40 | 14.99 | 14.07 | Acrylic: | 48.24 | 49.66 | 48.95 |
| | | | | | Rayon: | 51.76 | 50.34 | 51.05 |

percent or less except for the two rayon-acetate and all-rayon fabrics. One station's value for RT-1 was more than twice that found at the other station. Variance in the RT-2 values was much less. The all-rayon fabric amounts were also very different.

**Fiber and Finish Analyses**—Analyses for both qualitative and quantitative fiber and finish were made at the two stations. As shown in table 3, both stations agreed on types of fibers present in each fabric studied. Results also agreed with information given at time of purchase. Since three fabrics were purchased as single fiber fabrics and qualitative testing verified their contents, no attempt was made to determine the fibers quantitatively. The nine blended fabrics were each analyzed quantitatively using appropriate methods for each pair of fibers.

Results on fiber contents at the two stations sometimes varied (see table 3). With four blends, the difference was more than 1 percent. Considering the difficulties in completely separating different fibers, the difference perhaps was not truly significant. Also, some mechanical loss in the series of finish extractions was probable.

The greatest difference in values between the two stations, 1.75 percent, occurred with the rayon-acetate fabric RT-1. Both acrylic-rayon fabrics showed slightly more than 1 percent difference in the two sets of values.

Comparison of experimental values for fiber content with information given purchaser showed that only the two wool-nylon blends and one rayon-acetate (RT-1) were not definitely within the allowable tolerance range specified under the Textile Products Fiber Identification Act. Both wool-nylon blends had more nylon than expected; RT-1 showed a higher percent of acetate than was listed. Since these fabrics probably were produced prior to the effective date of the Act (March 3, 1960), they could not be considered illegally labeled.

Determinations of kinds of finish present on fabrics indicated several finishes on each. Comparison of reports from the two stations (table 4) making these determinations again showed some variation. Previous studies at station W indicated that selective solvents did not always give complete and clear-cut removals of some finishes. Possibly, the repeated heating of specimens to constant weight for the parallel quantitative finish removal may have caused partial breakdown of resins and, therefore, premature removal of such fractions. If so, identification reactions might erroneously indicate the presence of certain compounds in specific extracts.

Some doubt existed that each fabric contained a pyridine-base water repellent agent, particularly with the melamine or urea-formaldehyde resin finishes. Both finishes impart some degree of water repellency, although they are not primarily used for that purpose.

The presence of reducing compounds suggested that a small amount of either formaldehyde alone or low molecular weight formaldehyde-base resins probably were released in the extraction process. Such release gives the effect of reducing compounds in the qualitative test for identification of specific components in this extract.

**Table 4. Qualitative finish analysis of fabrics as purchased**

| Fabric code | Freon TF extract | | Ethyl alcohol extract | | Water extract | | 0.1N HCl extract | |
|---|---|---|---|---|---|---|---|---|
| | Station M test | Station W test | Station M test | Station W test | Station M test | Station W test | Station M test | Station W test |
| W-1 | Oil, stearamide, wax | Wax | Soap | Soap | MC* or gelatin | Gums | Pyridine-base WP†, VR‡ | MF§ |
| W-2 | Wax | Wax | .7% or less weight loss | Soap | MC or gelatin | Gums | Pyridine-base WP, MF | MF |
| WN-1 | Oils (trace), wax | Wax | Soap | Soap | MC or gelatin | Gums, glucose | Pyridine-base WP, MF | MF reducing compounds |
| WN-2 | Oil, stearamide, wax | Wax | Soap | Soap | MC or gelatin | Gums, glucose | Pyridine-base WP, MF | MF reducing compounds |
| WA-1 | Oils, wax | Wax | .5% or less weight loss | Soap | No loss in weight | Gums, glucose | Pyridine-base WP, VR | MF reducing compounds |
| WA-2 | Oils (trace), wax | Wax | Soap | Soap | MC or gelatin | Gums, glucose | Pyridine-base WP, MF | MF reducing compounds |
| WP-1 | Oils (trace), wax | Wax | .6% or less weight loss | Soap | MC or gelatin | Gums, glucose | Pyridine-base WP, MF | MF reducing compounds |
| R-1 | Oils (trace), wax | Wax | .2% or less weight *gain* | Soap | MC or gelatin | Gums, glucose | Pyridine-base WP, VR | MF reducing compounds |
| RT-1 | Oils (trace), wax | Wax | Phenol or cresol | Soap | Gums, mosses, or albumen | Gums, glucose | Pyridine-base WP, VR | MF reducing compounds |
| RT-2 | Oil, stearamide, wax | Wax | Cationic softener | Soap | MC or gelatin | Gums, glucose | Pyridine-base WP, VR | MF reducing compounds |
| RA-1 | Oils (trace), wax | Wax | Cationic softener | Soap | Gums, mosses, or albumen | Gums, glucose | Pyridine-base WP, MF | MF reducing compounds |
| RA-2 | Oils (trace), wax | Wax | .2% or less weight loss | Soap | MC or gelatin | Gums, glucose | Pyridine-base WP, urea-HCHO | MF reducing compounds |

*MC = methyl cellulose. † WP = water proofing agent. ‡ VR = vinylidene resin. § MF = melamine-formaldehyde resin.

Analysis for kinds and amounts of finishes was less clear-cut in providing complete separation and identification than were procedures for fiber content determinations. This difficulty is indicated when results from the two stations are compared (see table 3). One major problem was the small amount of finish on the small size specimens used for analysis, particularly in fabrics with only small percentages of finish.

The finish results indicated only small differences for 8 of the 12 fabrics. The other four fabrics varied from the 1.22-percent difference in WN-1 to more than 8 percent for RT-1. Considering the problems inherent in these determinations, probably only the all-rayon and RT-1 cases showed significant variations.

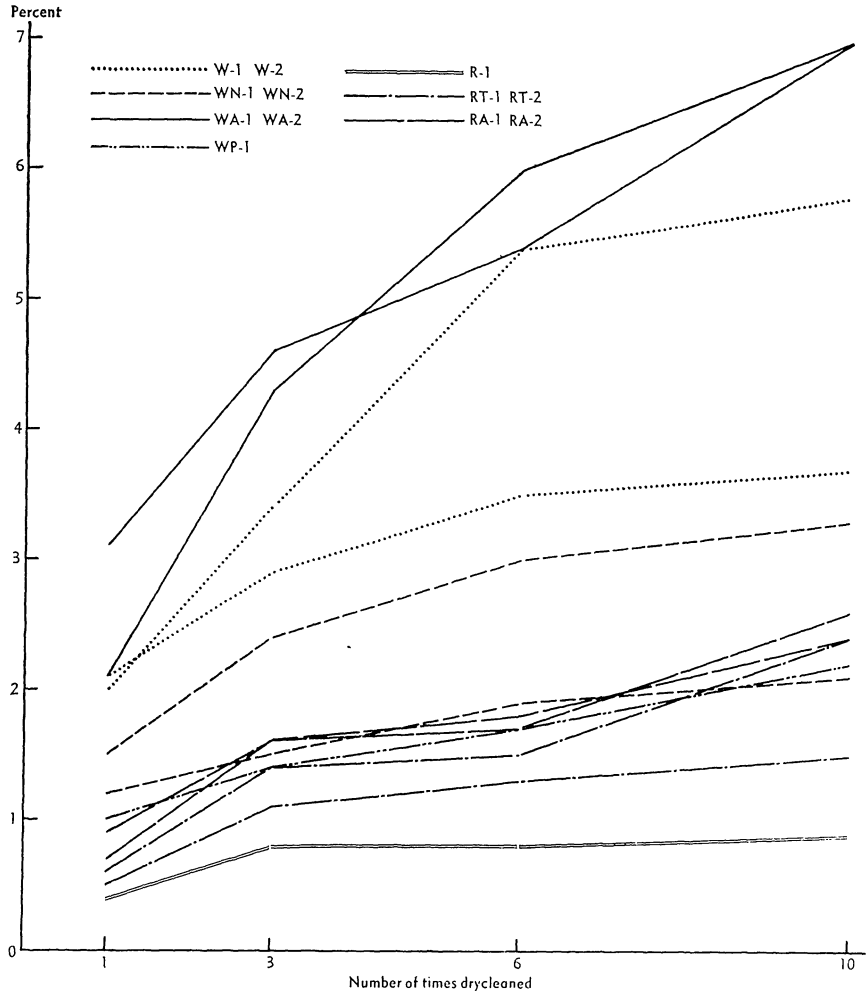


**Figure 1. Effect (percent shrinkage) of drycleaning on warp dimensional stability of fabrics.**

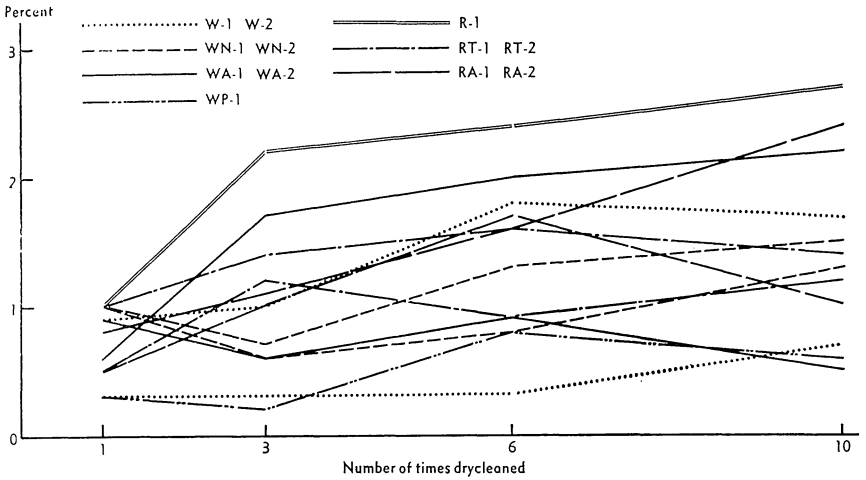


**Figure 2. Effect (percent shrinkage) of drycleaning on filling dimensional stability of fabrics.**

## Effect of Drycleaning on Certain Physical Properties

Visual inspection after drycleaning indicated that the hand or feel and color of most fabrics were not affected. Exceptions were the rayon blends which changed in hand and one rayon-acrylic (RA-2) which showed fuzzing.

Although fabrics varied in construction, the number of yarns per inch and weight were not affected by drycleaning.

**Dimensional Changes**—Figures 1 and 2 show dimensional changes in fabrics at specified intervals of drycleaning. WA-1 and WA-2 showed the greatest warp shrinkage—7 percent after the 10th drycleaning. W-1 and W-2 ranked next with the greatest change occurring during the first six drycleanings. The all-wool fabric, W-1, which had been sponged and treated to set the width and length, showed less shrinkage than W-2. The wool-nylon blend, WN-2, which had been chemically treated for dimensional stability, changed less than WN-1 which had no special finish. The rayon-acetate blend, RT-2, with a crease-resistant treatment, shrank less than RT-1 which was without such a finish.

Drycleaning had little effect upon dimensional stability of fabrics in the filling direction (see figure 2).

**Thickness**—This characteristic tended to increase with successive drycleanings. Thickness of the higher priced, specially finished, all-wool fabric, W-1, increased 0.002 inch after 10 drycleanings whereas thickness of the lower priced, untreated, all-wool fabric, W-2, increased 0.012 inch.

A similar relationship was evidenced in the wool-nylon blends. Fabrics containing rayon increased no more than 0.002 inch after 10 drycleanings. Wool blends increased approximately 0.005 inch.

**Tear Resistance**—Fabrics varied significantly in tear resistance. In general, fabrics containing rayon had higher tear resistance than did those containing wool. The rayon-acetate twill, RT-2, with a crease-resistant finish, was less resistant to tearing than was RT-1 which was without such finish.

During the first six drycleanings, rayon fabrics showed variability in warp tear resistance (see figure 3). Wool fabrics exhibited little change in warp tear resistance during drycleaning. Between two fabrics of similar fiber content, the plain weave with the lower thread count exhibited greater tear resistance than the twill. Greater yarn mobility due to thread count was possibly the important factor here.

Drycleaning had little effect on the filling tear resistance of fabrics (see figure 4, page 16).

**Stiffness**—After the first drycleaning, fabrics containing 50 percent or more rayon decreased markedly in stiffness, both in the warp and filling, whereas all the wools varied slightly (see table 5).

**Table 5. Stiffness in fabrics before and after drycleaning**

| Fabric code | Number of drycleanings | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | | 1 | | 3 | | 6 | | 10 | |
| | Warp | Filling | Warp | Filling | Warp | Filling | Warp | Filling | Warp | Filling |
| | centimeters | | | | | | | | | |
| W-1 | 1.84 | 1.68 | 1.90 | 1.72 | 1.86 | 1.74 | 1.88 | 1.70 | 1.89 | 1.75 |
| W-2 | 1.86 | 1.64 | 1.95 | 1.70 | 1.94 | 1.73 | 1.93 | 1.76 | 1.93 | 1.80 |
| WN-1 | 1.76 | 1.55 | 1.77 | 1.58 | 1.71 | 1.55 | 1.70 | 1.53 | 1.74 | 1.63 |
| WN-2 | 1.88 | 1.70 | 1.84 | 1.76 | 1.87 | 1.76 | 1.82 | 1.71 | 1.88 | 1.73 |
| WA-1 | 1.54 | 1.36 | 1.56 | 1.44 | 1.54 | 1.44 | 1.50 | 1.44 | 1.53 | 1.48 |
| WA-2 | 2.21 | 1.68 | 2.01 | 1.66 | 1.98 | 1.70 | 1.94 | 1.68 | 1.94 | 1.66 |
| WP-1 | 1.54 | 1.48 | 1.55 | 1.48 | 1.54 | 1.49 | 1.57 | 1.48 | 1.61 | 1.55 |
| R-1 | 1.94 | 1.87 | 1.69 | 1.78 | 1.62 | 1.70 | 1.62 | 1.71 | 1.61 | 1.74 |
| RT-1 | 3.02 | 1.98 | 2.18 | 1.53 | 1.88 | 1.38 | 1.80 | 1.38 | 1.74 | 1.36 |
| RT-2 | 2.18 | 1.79 | 1.91 | 1.57 | 1.85 | 1.54 | 1.77 | 1.53 | 1.78 | 1.55 |
| RA-1 | 1.82 | 1.34 | 1.84 | 1.42 | 1.74 | 1.45 | 1.72 | 1.42 | 1.72 | 1.43 |
| RA-2 | 2.72 | 1.77 | 2.26 | 1.66 | 2.04 | 1.63 | 2.01 | 1.59 | 1.95 | 1.56 |

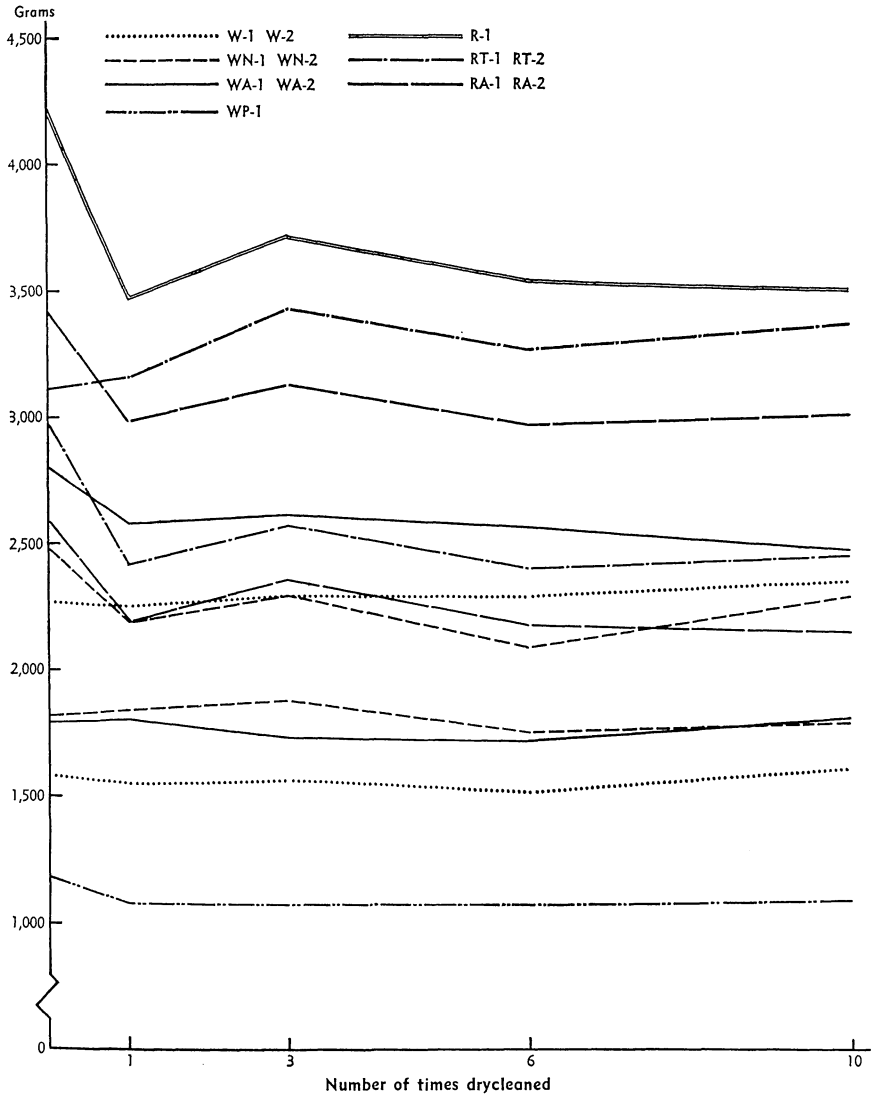


**Figure 3. Effect of drycleaning on warp tear resistance of fabrics.**

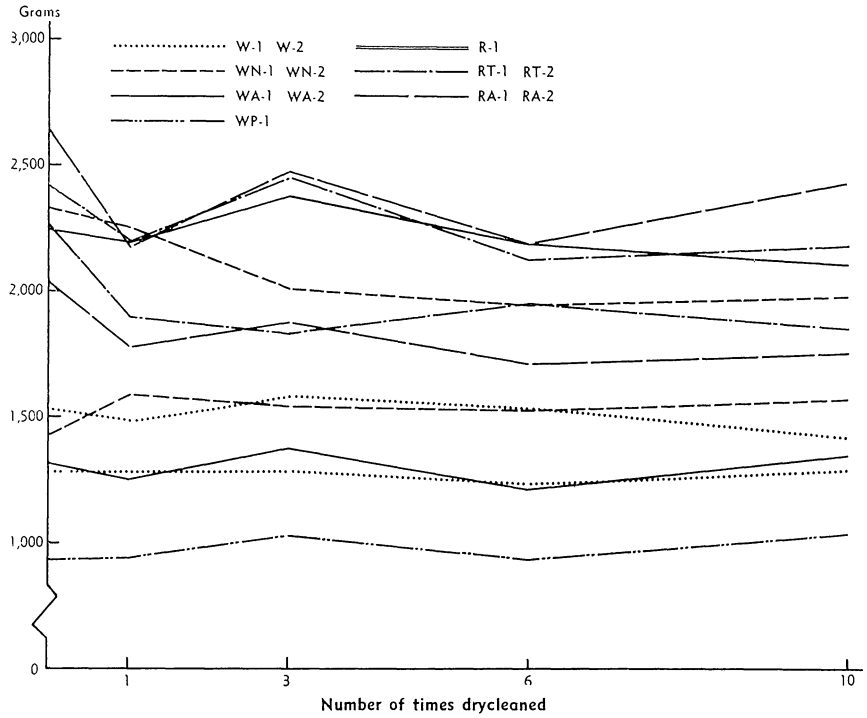


**Figure 4. Effect of drycleaning on filling tear resistance of fabrics.**

**Wrinkle Recovery and Pilling**—Changes in these characteristics due to drycleaning were not significant.

## Effect of Laundering on Certain Physical Properties

Only 2 of the 12 fabrics, WN-2 and R-1, were labeled washable (see table 1, page 4). However, manmade fiber blends are often laundered by consumers so all fabrics were treated alike.

Visual observation after laundering showed only slight changes in color except for the wool-nylon blends which developed a pink cast. Most fabrics were blends of white and dark fibers; therefore, if fabrics became more compact, they darkened. Slight fuzzing or pilling was noticed in some fabrics, especially W-1, WN-1, R-1, RT-2, and RA-2. Some fabrics changed in "hand;" W-1 and WN-1 became harsh and RT-1 and RA-2 softened.

**Dimensional Changes**—Tumbler action produced greater shrinkage of skirt fabrics than did agitator action (figures 5, 6, 7, and 8). By either laundry method, shrinkage in the warp direction was greatest. As expected, the all-wool fabrics, not having been treated for washability,

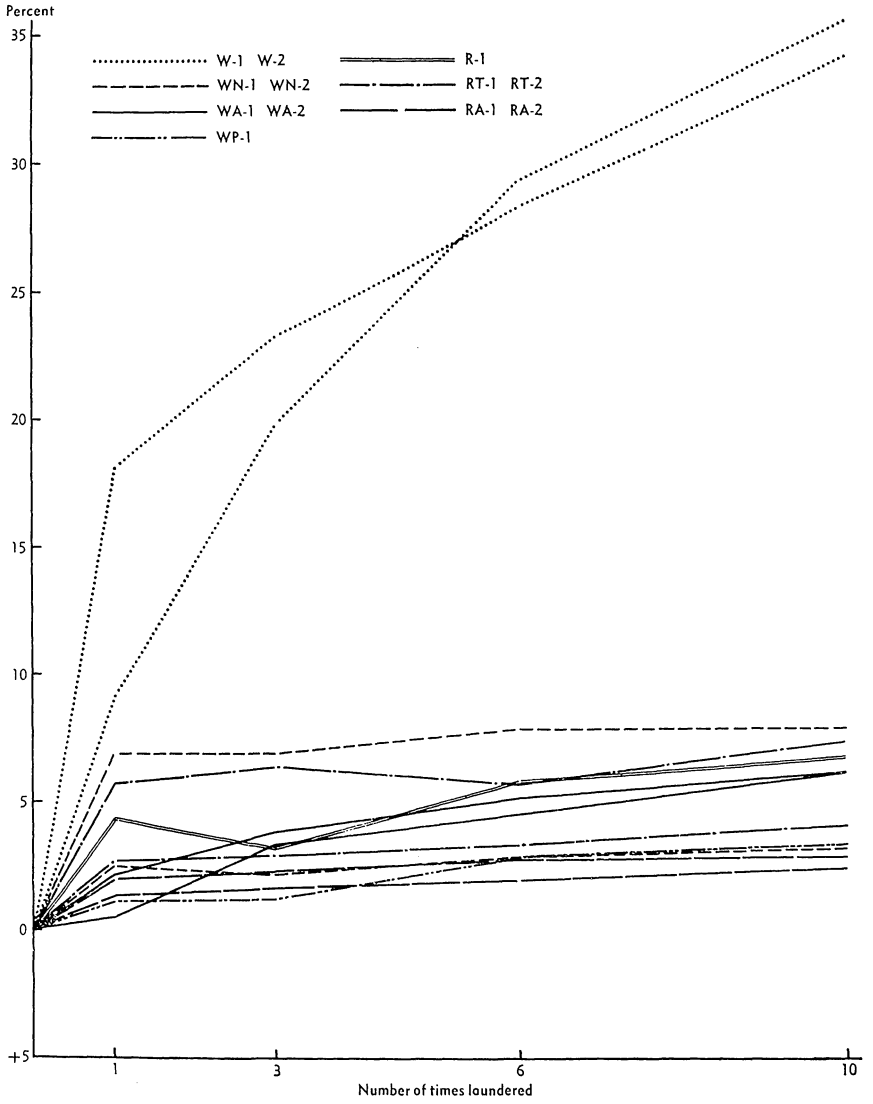


**Figure 5. Effect (percent shrinkage) of laundering on warp dimensional stability of fabrics—tumbler method.**

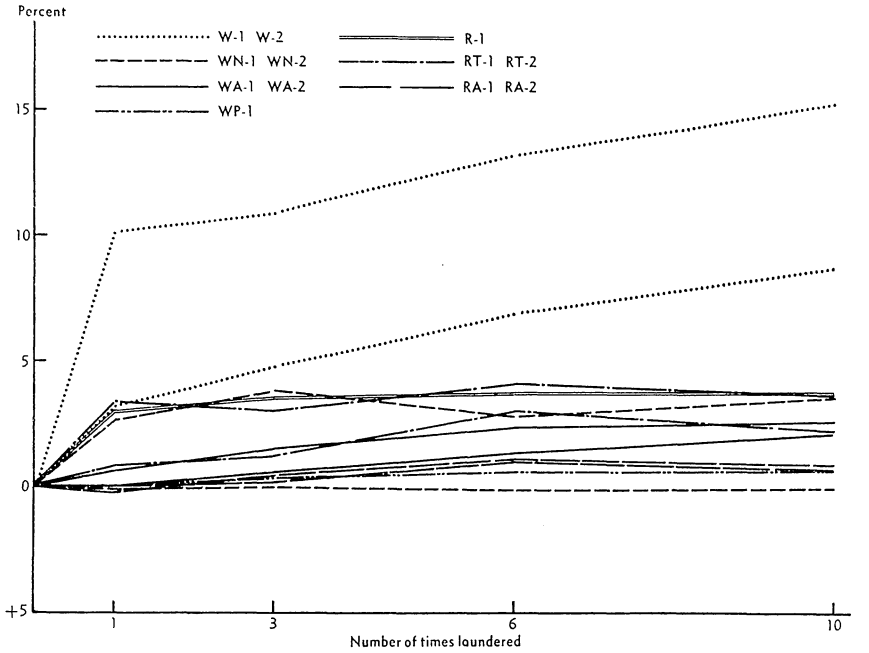


**Figure 6. Effect (percent shrinkage) of laundering on warp dimensional stability of fabrics—agitator method.**

shrank more than the other fabrics. With the addition of 15 percent nylon, shrinkage was reduced. The wool-nylon blend, WN-2, which was treated for washability (Dylanized), was more dimensionally stable than WN-1. The acrylic-wool and polyester-wool blends were likewise more stable to laundering than the all-wool fabrics. Although the all-rayon fabric was labeled washable, it shrank more than did the rayon blends.

**Thickness**—Changes in thickness followed the pattern of shrinkage; where shrinkage was high, thickness was great. Likewise, tumbler action caused greater increases in fabric thickness than did agitator action.

**Weight**—Changes in fabric weights were successively higher after each treatment and, again, followed the pattern established for dimensional change.

**Tear Resistance**—In all fabrics, tear resistance of the warp was higher than of the filling (table 6, page 21). Before laundering, tear resistance of the warp was highest for R-1. In the filling direction, tear often shifted to the warp, making it impossible to obtain a reading.

The lowest tear values were recorded for WP-1; laundering had little effect on its tear resistance. With the all-wool and wool-nylon blends, tear strengths increased with progressive tumbler washing. With all other fabrics, tear strength progressively decreased. The greatest decreases oc-

curred in the all-rayon and rayon-acrylic blends. Tear resistance of fabrics washed with tumbler action was generally higher than those washed with agitator action.

**Stiffness**—Fabric stiffness was greater in the warp than in the filling direction (table 7, page 22). Tumbler-washed W-2 and WP-1 were stiffer than when agitator washed. These fabrics were also stiffer after treatment than before. R-1, RT-1, RT-2, and RA-2 were decidedly stiffer when new than after laundering.

The agitator-washed rayon-acetate blends, especially RT-1, were stiffer than the tumbler-washed. For the remaining six fabrics, stiffness

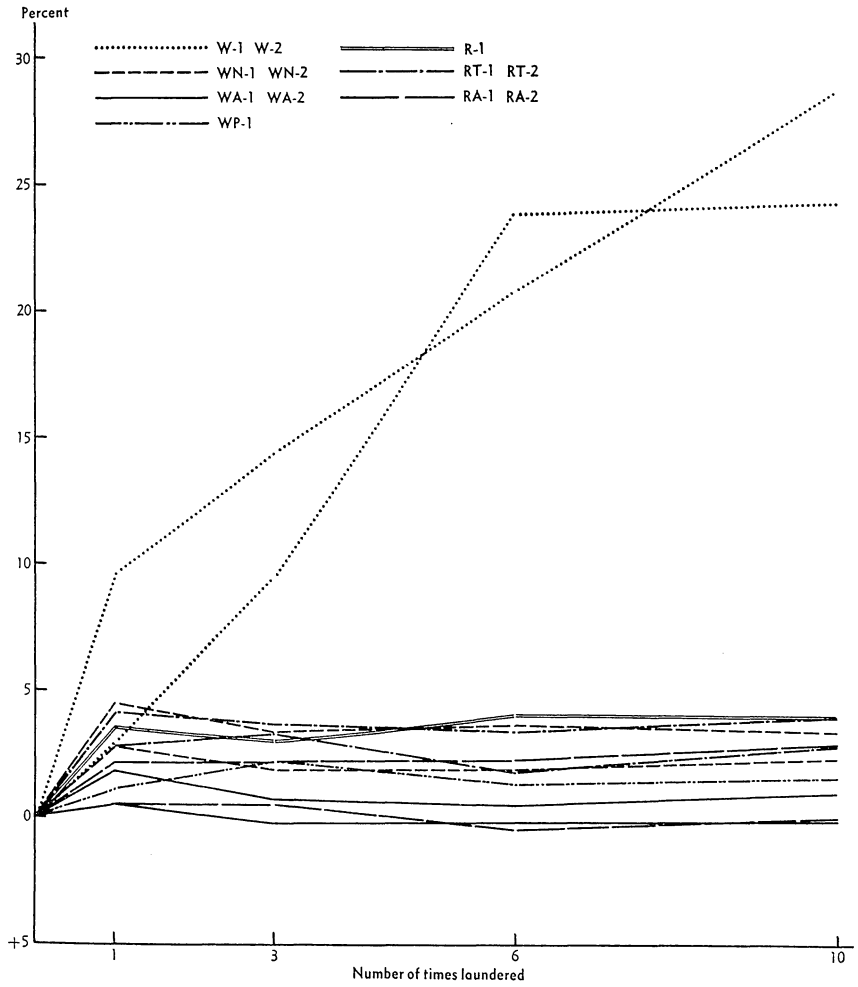


**Figure 7. Effect (percent shrinkage) of laundering on filling dimensional stability of fabrics—tumbler method.**

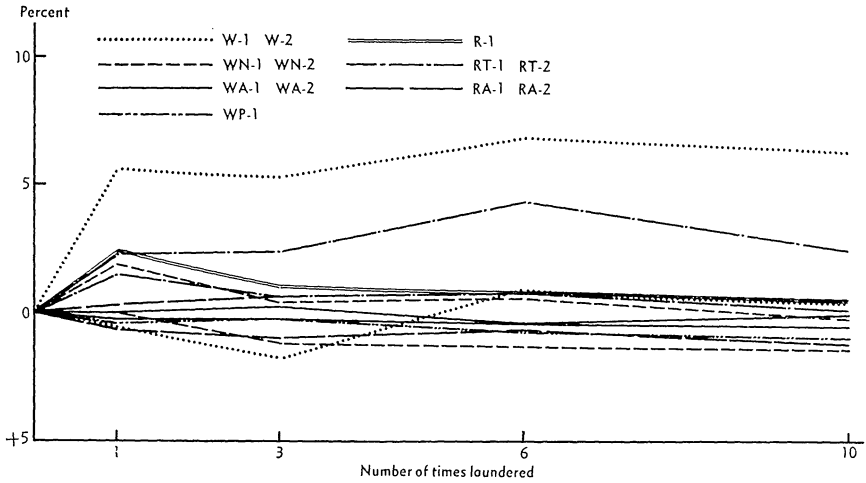


**Figure 8. Effect (percent shrinkage) of laundering on filling dimensional stability of fabrics—agitator method.**

measures were nearly alike; agitator-treated fabrics generally were higher in stiffness than the tumbler-treated.

**Wrinkle Recovery**—Fabrics generally had lower wrinkle recovery after laundering by the agitator action than by the tumbler action. Wool-containing fabrics showed better recovery than rayon fabrics except RA-1 and RA-2 which were as good or better than WA-1, WA-2, and WP-1.

**Pilling**—This characteristic varied significantly among fabrics. Wool-containing fabrics showed the greatest tendency for pills to adhere to the fabric surface. The rayon-acetate blends showed the greatest resistance for pills adhering to the fabric surface but pills adhered to the pilling disk.

## Stress-Strain Properties of Fabrics

Stress-strain properties of the original, laundered, and drycleaned fabrics are given in tables 8 and 9 (pages 23 and 24).

### Original Fabrics

All samples stressed in the warp direction had a higher percentage of work recovery and less unrecovered elongation than did samples stressed in the filling. The lowest percentage of work recovery for fabric samples was obtained in the first cycle. Work recovery values for the 20th and last cycles were substantially higher than those for the 1st cycle.

## Table 6. Tear resistance of fabrics before and after laundering

| Fabric code | Number of washing treatments | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | | 3 | | 6 | | 10 | |
| | | Agitator | Tumbler | Agitator | Tumbler | Agitator | Tumbler | Agitator | Tumbler |
| | | | | **Warp** | | | | | |
| | | | | grams | | | | | |
| W-1 | 1,528 | 1,456 | 1,463 | 1,506 | 1,494 | 1,512 | 1,618 | 1,588 | 1,882 |
| W-2 | 2,306 | 2,212 | 2,225 | 2,194 | 2,269 | 2,156 | 2,394 | 2,075 | 2,575 |
| WN-1 | 1,866 | 1,819 | 1,988 | 1,806 | 1,944 | 1,731 | 1,856 | 1,988 | 2,194 |
| WN-2 | 2,350 | 2,306 | 2,212 | 2,286 | 2,388 | 2,138 | 2,431 | 2,178 | 2,425 |
| WA-1 | 2,825 | 2,732 | 2,706 | 2,525 | 2,581 | 2,369 | 2,394 | 1,981 | 2,350 |
| WA-2 | 1,825 | 1,556 | 1,775 | 1,500 | 1,550 | 1,594 | 1,544 | 1,500 | 1,668 |
| WP-1 | 1,090 | 994 | 1,106 | 1,000 | 1,118 | 1,050 | 1,137 | 981 | 1,050 |
| R-1 | 4,260 | 4,450 | 4,244 | 3,862 | 3,882 | 2,925 | 3,512 | 1,812 | 3,313 |
| RT-1 | 3,225 | 2,868 | 3,356 | 1,918 | 2,482 | 1,738 | 2,144 | 1,750 | 2,194 |
| RT-2 | 2,903 | 2,794 | 2,800 | 2,331 | 2,744 | 1,988 | 2,350 | 1,518 | 2,344 |
| RA-1 | 2,647 | 2,556 | 2,450 | 1,832 | 2,468 | 2,144 | 2,512 | 2,050 | 2,531 |
| RA-2 | 3,228 | 2,825 | 3,119 | 2,619 | 2,300 | 2,225 | 2,788 | 2,400 | 2,975 |
| | | | | **Filling** | | | | | |
| | | | | grams | | | | | |
| W-1 | 1,266 | 1,206 | 1,306 | 1,225 | 1,332 | 1,262 | 1,500 | 1,262 | 1,762 |
| W-2 | 1,553 | 1,581 | 1,600 | 1,544 | 1,588 | 1,475 | 1,669 | 1,369 | 1,881 |
| WN-1 | 1,400 | 1,475 | 1,625 | 1,538 | 1,556 | 1,475 | 1,631 | 1,419 | 1,538 |
| WN-2 | 2,231 | 2,188 | 2,056 | 1,975 | 2,406 | 2,006 | 2,212 | 1,775 | 2,269 |
| WA-1 | 2,210 | 2,200 | 2,300 | 2,062 | 2,231 | 1,981 | 1,900 | 1,575 | 2,006 |
| WA-2 | 1,306 | 1,019 | 1,238 | 1,088 | 1,244 | 1,068 | 1,225 | 1,137 | 1,294 |
| WP-1 | 996 | 912 | 887 | 932 | 1,038 | 925 | 1,012 | 875 | 1,169 |
| R-1* | | | | | | | | | |
| RT-1 | 2,391 | 2,144 | 2,662 | 1,268 | 1,969 | 1,075 | 1,462 | 1,112 | 1,375 |
| RT-2 | 2,222 | 2,356 | 2,306 | 1,800 | 2,056 | 1,400 | 1,763 | 1,044 | 1,968 |
| RA-1 | 2,000 | 1,969 | 1,994 | 1,513 | 1,956 | 1,638 | 1,944 | 1,600 | 2,100 |
| RA-2 | 2,666 | 2,219 | 2,400 | 1,962 | 2,488 | 1,588 | 2,288 | 1,919 | 2,350 |

* Unbalanced fabric—tear direction shifted making measurement impossible.

**Table 7. Stiffness of fabrics before and after laundering**

| Fabric code | Number of washing treatments | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | | 3 | | 6 | | 10 | |
| | | Agitator | Tumbler | Agitator | Tumbler | Agitator | Tumbler | Agitator | Tumbler |
| | | | | **Warp** | | | | | |
| | | | | centimeters | | | | | |
| W-1 .... | 1.83 | 1.86 | 1.84 | 1.91 | 2.08 | 1.88 | 2.32 | 1.52 | 1.98 |
| W-2 .... | 1.83 | 1.97 | 1.98 | 1.99 | 2.13 | 1.91 | 2.29 | 1.98 | 2.43 |
| WN-1 .. | 1.74 | 1.82 | 1.78 | 1.79 | 1.78 | 1.70 | 1.73 | 1.77 | 1.74 |
| WN-2 .. | 1.83 | 1.78 | 1.68 | 1.72 | 1.71 | 1.78 | 1.69 | 1.73 | 1.62 |
| WA-1 .. | 1.52 | 1.52 | 1.48 | 1.63 | 1.52 | 1.52 | 1.50 | 1.54 | 1.47 |
| WA-2 .. | 2.20 | 2.01 | 1.80 | 1.88 | 1.82 | 1.94 | 1.76 | 1.88 | 1.79 |
| WP-1 ... | 1.53 | 1.56 | 1.50 | 1.53 | 1.51 | 1.54 | 1.50 | 1.50 | 1.49 |
| R-1 .... | 1.89 | 1.41 | 1.44 | 1.38 | 1.48 | 1.45 | 1.42 | 1.48 | 1.41 |
| RT-1 ... | 2.91 | 2.24 | 1.75 | 2.16 | 1.73 | 2.22 | 1.62 | 2.16 | 1.58 |
| RT-2 ... | 2.22 | 1.79 | 1.73 | 1.78 | 1.67 | 1.75 | 1.56 | 1.77 | 1.54 |
| RA-1 ... | 1.82 | 1.61 | 1.49 | 1.63 | 1.59 | 1.58 | 1.54 | 1.53 | 1.54 |
| RA-2 ... | 2.66 | 1.85 | 1.77 | 1.77 | 1.69 | 1.66 | 1.62 | 1.67 | 1.68 |
| | | | | **Filling** | | | | | |
| | | | | centimeters | | | | | |
| W-1 .... | 1.67 | 1.65 | 1.79 | 1.72 | 2.09 | 1.78 | 2.35 | 1.75 | 2.57 |
| W-2 .... | 1.64 | 1.80 | 1.86 | 1.92 | 2.01 | 1.98 | 2.21 | 1.88 | 2.37 |
| WN-1 .. | 1.53 | 1.56 | 1.57 | 1.66 | 1.78 | 1.68 | 1.61 | 1.66 | 1.60 |
| WN-2 .. | 1.68 | 1.63 | 1.55 | 1.70 | 1.62 | 1.70 | 1.66 | 1.66 | 1.59 |
| WA-1 .. | 1.35 | 1.34 | 1.38 | 1.39 | 1.36 | 1.27 | 1.36 | 1.42 | 1.39 |
| WA-2 .. | 1.67 | 1.58 | 1.54 | 1.59 | 1.61 | 1.57 | 1.51 | 1.50 | 1.56 |
| WP-1 ... | 1.46 | 1.44 | 1.50 | 1.48 | 1.47 | 1.51 | 1.46 | 1.44 | 1.45 |
| R-1 .... | 1.83 | 1.55 | 1.55 | 1.62 | 1.52 | 1.60 | 1.54 | 1.59 | 1.69 |
| RT-1 ... | 1.93 | 1.54 | 1.38 | 1.49 | 1.35 | 1.52 | 1.32 | 1.55 | 1.26 |
| RT-2 ... | 1.76 | 1.51 | 1.48 | 1.49 | 1.41 | 1.51 | 1.41 | 1.45 | 1.36 |
| RA-1 ... | 1.31 | 1.34 | 1.35 | 1.31 | 1.26 | 1.36 | 1.31 | 1.29 | 1.52 |
| RA-2 ... | 1.81 | 1.47 | 1.42 | 1.48 | 1.36 | 1.44 | 1.40 | 1.45 | 1.40 |

**Table 8. Warp stress-strain properties of fabrics**

| Fabric code | Treatment | Number of times treated | Percent work recovery | | | Set (in inches) | | Percent work absorption retained |
|---|---|---|---|---|---|---|---|---|
| | | | 1st cycle | 20th cycle | Last cycle | 1st cycle | Last cycle | |
| W-1 | None | 0 | 53 | 72 | 68 | 0.15 | 0.46 | 77 |
| | Drycleaned | 10 | 46 | 64 | 60 | 0.22 | 0.58 | 58 |
| | Laundered | 10 | 30 | 52 | 58 | 0.42 | 1.72 | 49 |
| W-2 | None | 0 | 69 | 71 | 75 | 0.08 | 0.30 | 82 |
| | Drycleaned | 10 | 44 | 65 | 60 | 0.24 | 0.58 | 64 |
| | Laundered | 10 | 33 | 49 | 60 | 0.72 | 1.74 | 53 |
| WN-1 | None | 0 | 49 | 65 | 70 | 0.40 | 0.75 | 54 |
| | Drycleaned | 10 | 44 | 61 | 62 | 0.30 | 0.80 | 54 |
| | Laundered | 10 | 35 | 50 | 58 | 0.60 | 1.44 | 49 |
| WN-2 | None | 0 | 43 | 62 | 66 | 0.52 | 1.22 | 50 |
| | Drycleaned | 10 | 38 | 58 | 70 | 0.46 | 1.20 | 48 |
| | Laundered | 10 | 37 | 53 | 71 | 0.64 | 1.50 | 51 |
| WA-1 | None | 0 | 52 | 74 | 74 | 0.19 | 0.42 | 58 |
| | Drycleaned | 10 | 36 | 59 | 59 | 0.40 | 0.95 | 43 |
| | Laundered | 10 | 43 | 48 | 66 | 0.37 | 0.80 | 59 |
| WA-2 | None | 0 | 60 | 72 | 69 | 0.06 | 0.26 | 59 |
| | Drycleaned | 10 | 38 | 61 | 63 | 0.37 | 0.92 | 39 |
| | Laundered | 10 | 43 | 56 | 63 | 0.25 | 0.70 | 58 |
| WP-1 | None | 0 | 68 | 82 | 84 | 0.05 | 0.12 | 72 |
| | Drycleaned | 10 | 47 | 63 | 76 | 0.02 | 0.17 | 63 |
| | Laundered | 10 | 54 | 68 | 74 | 0.10 | 0.26 | 64 |
| R-1 | None | 0 | 60 | 83 | 100 | 0.10 | 0.26 | 45 |
| | Drycleaned | 10 | 37 | 66 | 65 | 0.14 | 0.34 | 64 |
| | Laundered | 10 | 32 | 65 | 70 | 0.45 | 0.84 | 40 |
| RA-1 | None | 0 | 52 | 71 | 71 | 0.16 | 0.42 | 54 |
| | Drycleaned | 10 | 43 | 50 | 61 | 0.23 | 0.65 | 53 |
| | Laundered | 10 | 46 | 56 | 64 | 0.22 | 0.56 | 56 |
| RA-2 | None | 0 | 53 | 76 | 82 | 0.10 | 0.28 | 52 |
| | Drycleaned | 10 | 50 | 53 | 54 | 0.15 | 0.45 | 56 |
| | Laundered | 10 | 45 | 61 | 65 | 0.18 | 0.44 | 53 |
| RT-1 | None | 0 | 50 | 74 | 82 | 0.16 | 0.39 | 44 |
| | Drycleaned | 10 | 39 | 57 | 70 | 0.27 | 0.61 | 40 |
| | Laundered | 10 | 32 | 57 | 74 | 0.69 | 1.16 | 36 |
| RT-2 | None | 0 | 47 | 71 | 76 | 0.20 | 0.49 | 38 |
| | Drycleaned | 10 | 37 | 62 | 55 | 0.30 | 0.61 | 47 |
| | Laundered | 10 | 41 | 59 | 64 | 0.47 | 0.88 | 38 |

**Table 9. Filling stress-strain properties of fabrics**

| Fabric code | Treatment | Number of times treated | Percent work recovery | | | Set (in inches) | | Percent work absorption retained |
|---|---|---|---|---|---|---|---|---|
| | | | 1st cycle | 20th cycle | Last cycle | 1st cycle | Last cycle | |
| W-1 | None | 0 | 44 | 56 | 63 | 0.44 | 1.22 | 64 |
| | Drycleaned | 10 | 40 | 54 | 53 | 0.26 | 0.82 | 69 |
| | Laundered | 10 | 35 | 48 | 57 | 0.34 | 1.14 | 66 |
| W-2 | None | 0 | 51 | 66 | 65 | 0.15 | 0.40 | 82 |
| | Drycleaned | 10 | 44 | 59 | 55 | 0.12 | 0.52 | 73 |
| | Laundered | 10 | 38 | 51 | 56 | 0.17 | 0.83 | 69 |
| WN-1 | None | 0 | 39 | 52 | 57 | 0.34 | 1.08 | 61 |
| | Drycleaned | 10 | 36 | 49 | 48 | 0.26 | 0.96 | 59 |
| | Laundered | 10 | 36 | 51 | 53 | 0.42 | 1.25 | 58 |
| WN-2 | None | 0 | 31 | 56 | 63 | 0.78 | 1.84 | 40 |
| | Drycleaned | 10 | 27 | 51 | 53 | 0.75 | 1.91 | 39 |
| | Laundered | 10 | 27 | 47 | 59 | 0.95 | 2.10 | 36 |
| WA-1 | None | 0 | 48 | 64 | 69 | 0.27 | 0.74 | 51 |
| | Drycleaned | 10 | 40 | 50 | 54 | 0.32 | 0.85 | 61 |
| | Laundered | 10 | 43 | 57 | 70 | 0.28 | 0.86 | 50 |
| WA-2 | None | 0 | 52 | 67 | 72 | 0.13 | 0.49 | 55 |
| | Drycleaned | 10 | 41 | 58 | 58 | 0.10 | 0.53 | 47 |
| | Laundered | 10 | 45 | 58 | 66 | 0.14 | 0.52 | 52 |
| WP-1 | None | 0 | 50 | 60 | 63 | 0.19 | 0.42 | 71 |
| | Drycleaned | 10 | 42 | 57 | 56 | 0.10 | 0.38 | 66 |
| | Laundered | 10 | 45 | 54 | 55 | 0.16 | 0.57 | 66 |
| R-1 | None | 0 | 36 | 61 | 72 | 0.38 | 0.93 | 29 |
| | Drycleaned | 10 | 30 | 52 | 61 | 0.58 | 1.19 | 29 |
| | Laundered | 10 | 25 | 43 | 53 | 0.70 | 1.36 | 22 |
| RA-1 | None | 0 | 41 | 66 | 66 | 0.42 | 1.12 | 38 |
| | Drycleaned | 10 | 39 | 56 | 61 | 0.28 | 0.86 | 40 |
| | Laundered | 10 | 38 | 51 | 59 | 0.54 | 1.20 | 35 |
| RA-2 | None | 0 | 35 | 60 | 59 | 0.24 | 0.75 | 37 |
| | Drycleaned | 10 | 36 | 45 | 63 | 0.39 | 1.03 | 43 |
| | Laundered | 10 | 42 | 50 | 55 | 0.48 | 1.17 | 39 |
| RT-1 | None | 0 | 29 | 57 | 75 | 0.50 | 1.09 | 35 |
| | Drycleaned | 10 | 31 | 55 | 66 | 0.72 | 1.32 | 30 |
| | Laundered | 10 | 27 | 55 | 69 | 0.86 | 1.48 | 27 |
| RT-2 | None | 0 | 33 | 56 | 64 | 0.39 | 0.85 | 36 |
| | Drycleaned | 10 | 32 | 52 | 59 | 0.36 | 0.40 | 39 |
| | Laundered | 10 | 29 | 49 | 55 | 0.68 | 1.28 | 38 |

Only the R-1 and RT-1 fabrics showed large differences between the work recovery values for the 20th and last cycles. For both fabrics the warp and filling work recoveries were higher for the last cycle than for the 20th cycle. This condition indicated that the amount of set per cycle was still increasing substantially after 20 loading periods.

Percentage of work recovery and percentage of the original work absorption retained after the last cycle were highest for the all-wools and wool-polyester fabrics. The wool-acrylic blend fabrics ranked next, followed by wool-nylon and rayon-acrylic blends. The rayon and rayon-acetate blends ranked substantially lower than the other fabrics, especially in the filling direction, in work recovery, and retention of work absorption.

### Treated, Unstressed Fabrics

Drycleaning samples containing wool slightly lowered their work recovery and retention of work absorption capacity, particularly for the all-wool and wool-acrylic fabrics. The same effect was found in both the warp and filling directions of the all-rayon fabric and the warp direction of the rayon-acetate blends.

Laundering greatly decreased the work recovery values of all-wool fabrics in both warp and filling directions and for WN-1 in the warp. This drastic reduction resulted from the high degree of set obtained because of fabric shrinkage which was pulled out under tensile stress. The fact that sets and losses in work recovery were greater in the warp than in filling directions might have resulted from higher warp than filling shrinkage.

### Treated, Stressed Fabrics

Combined treatments of drycleaning 10 times and 8 hours of tensile stress only slightly changed fabric properties of all 12 fabrics. The combined warp and filling wrinkle recoveries of all fabrics except RT-1 slightly dropped (see table 10). Laundering 10 times plus 8 hours of stress decreased wrinkle recovery for all fabrics. This decrease was greatest for the all-wool, all-rayon, and one wool-nylon (WN-1) fabrics.

Laundering plus stress materially changed fabric and yarn properties of the all-wool fabrics (see table 11). For most changes, however, laundering rather than stress apparently had the greatest effect. For example, the only notable changes caused by stressing the original all-wool fabrics were slight decreases in the warp and filling yarn elongations, the filling tex, and weight of the W-1 fabric. On the other hand, laundering alone increased fabric thread counts, weights, and thicknesses because of fabric shrinkage.

Changes were much larger for fabrics laundered by the tumbling procedure than for those laundered by the agitator procedure. Stressing after laundering tended to reduce filling thread counts, weights, and thicknesses (especially at the lower pressure) from those of the laun-

**Table 10. Percentages of loss in warp plus filling wrinkle recoveries of stressed fabrics which had been drycleaned or laundered**

| Fabric code | Treatment | |
|---|---|---|
| | Drycleaned 10 times | Laundered 10 times |
| | percent loss | |
| W-1 | 3.1 | 12.6 |
| W-2 | 6.1 | 15.3 |
| WN-1 | 5.3 | 11.7 |
| WN-2 | 4.1 | 6.9 |
| WA-1 | 5.7 | 9.0 |
| WA-2 | 5.2 | 7.5 |
| WP-1 | 4.7 | 6.6 |
| R-1 | 5.8 | 13.8 |
| RA-1 | 6.9 | 6.9 |
| RA-2 | 2.8 | 4.7 |
| RT-1 | +1.4 | 2.4 |
| RT-2 | 4:7 | 7.8 |

dered, unstressed fabrics. However, stressing did not return fabric properties to their original values.

Strengths of yarns taken from fabrics laundered by station T and then stressed were much lower than those taken from either the original or the original stressed fabrics, in spite of increased yarn tex. The combination of the agitator laundering procedure plus stress did not greatly decrease yarn strength. However, the filling strength and the filling yarn tex of the laundered W-2 fabric were significantly lower than those of the original.

Both yarn crimps and elongations were higher in laundered stressed fabrics than in the original stressed fabrics. Again this change was greater in fabrics tested at station T than in the fabrics tested at station W because of the greater fabric shrinkage.

Laundering plus stress did not significantly change the yarn and fabric properties, other than wrinkle recovery, of the other 10 fabrics.

Use of commercial names does not endorse those mentioned nor criticize those not named.

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**Table 11. Effects of laundering 10 times plus stress on physical properties of 100-percent wool fabrics**

| Fabric and yarn properties | W-1 | | | | | | W-2 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Original unstressed | Original stressed | Station T, unstressed | Station A, unstressed | Station T, stressed | Station A, stressed | Original unstressed | Original stressed | Station T, unstressed | Station A, unstressed | Station T, stressed | Station A, stressed |
| Thread count (number per inch) | | | | | | | | | | | | |
| Warp | 36 | 36 | 46 | 36 | 47 | 35 | 30 | 30 | 39 | 32 | 38 | 32 |
| Filling | 31 | 31 | 46 | 34 | 41 | 32 | 21 | 21 | 31 | 26 | 30 | 25 |
| Weight (ounce per sq. yd.) | 7.1 | 6.9 | 14.0 | 7.8 | 13.3 | 7.7 | 6.8 | 6.7 | 13.1 | 8.4 | 12.1 | 8.2 |
| Thickness (inches) at: | | | | | | | | | | | | |
| 0.1 pound per square inch | 0.046 | 0.046 | 0.132 | 0.080 | 0.110 | 0.071 | 0.036 | 0.037 | 0.150 | 0.093 | 0.126 | 0.082 |
| 1.0 pound per square inch | 0.039 | 0.039 | 0.099 | 0.054 | 0.093 | 0.051 | 0.028 | 0.029 | 0.106 | 0.066 | 0.101 | 0.062 |
| Compression | 0.007 | 0.007 | 0.033 | 0.026 | 0.017 | 0.020 | 0.008 | 0.008 | 0.044 | 0.027 | 0.025 | 0.020 |
| Wrinkle recovery (degrees) | | | | | | | | | | | | |
| Warp | | 160 | | | 133 | 144 | | 164 | | | 131 | 144 |
| Filling | | 158 | | | 141 | 137 | | 162 | | | 142 | 134 |
| Yarn tex | | | | | | | | | | | | |
| Warp | 79 | 79 | | | 86 | 81 | 104 | 104 | | | 113 | 110 |
| Filling | 84 | 79 | | | 86 | 82 | 109 | 106 | | | 118 | 96 |
| Yarn strength (pounds) | | | | | | | | | | | | |
| Warp | 0.48 | 0.48 | | | 0.28 | 0.46 | 0.65 | 0.66 | | | 0.47 | 0.66 |
| Filling | 0.50 | 0.46 | | | 0.26 | 0.44 | 0.66 | 0.61 | | | 0.38 | 0.52 |
| Yarn crimp (percent) | | | | | | | | | | | | |
| Warp | | 7.6 | | | 20.5 | 14.0 | | 3.8 | | | 25.4 | 14.0 |
| Filling | | 17.9 | | | 30.6 | 16.2 | | 10.4 | | | 25.3 | 18.3 |
| Yarn elongation (percent) | | | | | | | | | | | | |
| Warp | 27 | 20 | | | 31 | 22 | 24 | 24 | | | 30 | 28 |
| Filling | 27 | 24 | | | 33 | 24 | 27 | 31 | | | 38 | 25 |

# WHAT WAS FOUND

Based on questionnaire data, fabrics for girls winter skirts were purchased for laboratory evaluation. Since wool or wool-like fabrics were preferred by mothers and daughters, fabrics composed of all wool, wool and manmade fiber blends, and flannel-type rayon and rayon blends in gray shades were selected. Chemical analyses indicated that, in most instances, the fiber content specified at time of purchase was within allowable tolerances.

Among the criteria ranked high by mothers and daughters for winter school skirts was the fabric's ability to maintain its shape, original appearance, and fit. The stress-strain analysis indicated that all-wool and wool-polyester fabrics were higher than all-rayon and rayon-acetate blends in work recovery and retention of ability to absorb work. Theoretically, therefore, wool fabrics should be better than rayon fabrics in shape-retention. Wool-acrylic, wool-nylon, and rayon-acrylic blends were intermediate in work recovery properties. Since laundering and drycleaning influence these criteria, fabrics were analyzed after 0, 1, 3, 6, and 10 treatments.

In relation to fit and ability to hold shape, shrinking and stretching of fabrics are important. Wool fabrics shrank lengthwise with both types of cleaning but less with drycleaning than with laundering. In laundering, less shrinkage occurred with agitator action than with tumbler. Acrylic-wool blends with 60 percent or more Orlon shrank approximately 7 percent in length after 10 drycleanings, whereas the agitator washing method caused only 2 to 3 percent loss. Drycleaning had little effect on dimensional changes in the filling.

All fabrics labeled with special finishes were more expensive than fabrics without such finishes. The double sponged and decated wool fabric was more stable to drycleaning and washing by the agitator method than the other all-wool fabric. Of the wool blends containing 15 percent nylon, the material labeled washable and Dylanized was superior in dimensional stability. In wrinkle recovery the two rayon-acetate fabrics were similar even though one was labeled crease-resistant.

Regarding retention of original appearance, the gray shades were not affected by cleaning. Surface changes included some fuzzing of the 50/50 rayon-acrylic fabric. Wool and wool blends tended to pill but were superior in wrinkle recovery. When new, fabrics containing rayons were stiffer than those containing wool. However, after drycleaning the wools changed little and the rayons became limp.